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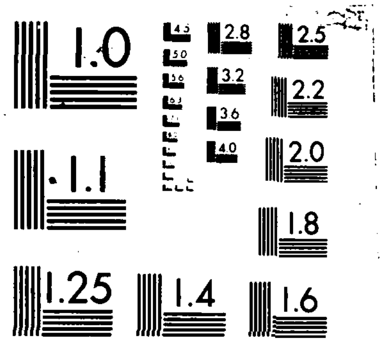

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INSTRUCTIONAL DESIGN: IMPACT OF SUBJECT MATTER AND COGNITIVE STYLES

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This paper reviews current research in neuropsychology, cognitive style, and instructional design. It provides a framework for further research in the most effective mode of information presentation, considering the interaction of cognitive style and training subject matter. The neuropsychological research addresses the role of the left and right hemispheres of the brain in human information processing. Research in cognitive psychology builds on the knowledge of hemispheric processing through the study of cognitive styles. This knowledge is then combined with research in instructional design and the nature of subject matter. This review then serves as a basis for combining the critical aspects of cognitive style and subject-matter content into a proposed identification of concerns relevant to the design of computer-based instruction.

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INSTRUCTIONAL DESIGN: IMPAC. OF SUBJECT MATTER AND COGNITIVE STYLES

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SUMMARY

Basic research in neuropsychology, learning theory, memory, and cognitive psychology have contributed to knowledge concerning human learning. This research has been applied to the identification of cognitive styles, defined as an individual's unique method of processing information. Research into ways to apply this knowledge through computer-based instruction, the increased use of microcomputers, and the introduction of artificial intelligence techniques into training has permitted more effective use of computer-based instruction in training applications. Instructional designers, however, are not currently provided with adequate techniques for the development of individualized instruction. Research also acknowledges the importance of taking into account the nature of the training subject-matter content. Guidelines concerning information presentation in computer-based instruction should be provided for instructional designers to allow for the individual cognitive style of the trainee and for differences in subject-matter content. This paper reviews current research in neuropsychology, cognitive style, and instructional design. It will provide a framework for further research in the most effective mode of information presentation, considering the interaction of cognitive style and training content.

PREFACE

The author would like to thank the Air Force Systems Command and the Air Force Office of Scientific Research for making possible a rewarding Summer Facility Research Fellowship at the Air Force Human Resources Laboratory, Logistics and Human Factors Division, Ground Operations Branch, Wright-Patterson Air Force Base, Ohio. I would like to express my sincere appreciation to the Laboratory, particularly to the Branch, for providing a stimulating working environment. All members of the Branch willingly provided enormous professional and personal support, which has been greatly appreciated. Special thanks go to Mr. Bertram Cream for his insightful guidance throughout the project; Mr. Lawrence Finegold for many helpful discussions and editorial comments; Dr. Lawrence Reed, Mr Michael Young, and Dr. Michael Venturino for helpful discussion; Ms. Rosemarie Preidis for sharing her knowledge about the Air Force; and Mrs. Katherine Paris and Mrs. Kathleen Moorer for administrative support.

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I. INTRODUCTION

Basic research in the areas of learning theory, memory, neuropsychology (hemisphericity), and cognitive psychology (information processing) have all made significant contributions to the knowledge of how human learning occurs. This knowledge has been applied to the identification of cognitive styles. Cognitive styles include the unique patterns an individual utilizes in processing information. Research into ways to apply this knowledge, including methodological development in the use of computer-based instruction, the advent of more powerful and inexpensive microcomputers, and the introduction of artificial intelligence techniques into training, has permitted more effective and cost-efficient use of computer-based instruction in a wide variety of training applications.

Instructional designers, however, are not currently provided with adequate tools and techniques for the development of instructional programs tailored to the individual needs of the trainee (learner). In many of the current training programs, it is assumed that all trainees process and store information in the same manner. It is the responsibility of trainees to match their learning to the format of the instruction. Recent research demonstrates that trainees process information differently (e.g., Kogan, 1971; Messick, 1966). For example, some individuals best retain information presented graphically and holistically, whereas others best process information serially (with verbal presentation). Some researchers (e.g., Moore & Nawrocki, 1978) also acknowledge the importance of taking into account the nature of the subject-matter or task characteristics when planning instruction. This knowledge can facilitate retention and eventual transfer of training to the job situation.

Currently, designers of computer-based instruction are not provided adequate guidelines for the development of programs which both meet individual cognitive style characteristics of trainees and allow for differences in the subject-matter content. The problem lies in the current lack of adequate, detailed knowledge of both certain critical aspects of cognitive style and the

manner in which to structure and present training material. If the elements of subject-matter content and cognitive style are consistently considered when planning instruction, it is proposed that training effectiveness and efficiency can be enhanced. With the development of guidelines for instructional designers, computer-based instruction shows promise in its capacity to allow for flexibility in instruction to meet individual needs.

The objective of this paper is to review current research in the areas of neuropsychology, cognitive psychology, and instructional design and to then develop proposed guidelines for the design of computer-based instruction which will provide a framework for further research. This paper first approaches this objective through a review of current research in neuropsychology and cognitive psychology. The neuropsychological research addresses the functions of the left and right hemispheres of the brain in human information processing. Research in cognitive psychology builds on the knowledge of hemispheric processing through the study of cognitive styles. The paper then combines this knowledge with research in instructional design and the nature of subject matter. This review then serves as a basis for combining the critical aspects of cognitive style and subject-matter content into a proposed identification of concerns relevant to the design of computer-based instruction.

II. CURRENT RESEARCH IN NEUROPSYCHOLOGY

Research into the organization and functioning of the human brain has resulted in the identification of two hemispheres having some separate but cooperatively shared responsibilities in the processing of information (e.g., Hart, 1983; Herrman, 1981; Luria, 1973; Kinsbourne, 1978; Ornstein, 1977). Kinsbourne (1978) and others discuss the basic factors of cerebral lateralization. The left hemisphere is primarily responsible for logical/deductive/analytic thought, verbal/alphanumeric functioning, and language development. The right hemisphere's role relates to holistic (global) thought, inductive reasoning, synthesis of information, and the processing of visual/spatial information. While the left hemisphere responds

to symbolic/verbal input, the right processes non-verbal (non-phonetic) input, as in tonal/musical information. The left hemisphere processes the names of individuals, whereas the right is associated with facial recognition and retention (e.g., Rubenzer, 1979). In tasks involving planning and mathematical calculation, the left hemisphere has primary processing responsibility. The right hemisphere emphasizes the processing of visual/spatial relationships (Herrman, 1981) and alternately aids in such tasks as driving a car (involving the synthesis of much information) and geometry (Franco & Sperry, 1977). The asymmetrical responsibilities of the human brain appear to be task-dependent to a large degree (Schwartz, Davidson, & Pugash 1976). Although each hemisphere accepts primary responsibility for certain functions, responsibilities may be shared for some tasks; however, functions appear to be located as described in approximately 98% of all right-handed persons and 75% of all left-handed persons (Wittrock, 1978).

The two hemispheres process information resulting from sensory input. Sensory input to the left side of the body (hand, eye, ear, etc.) is processed in the right hemisphere (e.g., Wittrock, 1978), and input to the right side of the body is processed in the left hemisphere. Studies such as Sperry's (1968) support this processing notion. Sperry displayed the word "keycase" to a number of subjects. The word "key" was displayed to the left visual field (implying right-hemisphere processing) and "case" to the right visual field (implying left-hemisphere processing). After viewing these words, the subjects were shown a list of words and asked to identify the word they were shown. The subjects identified "case" as the word shown earlier. Additionally, the subjects were asked to feel inside a bag for the object representing the word they had initially seen. In this case, the subjects identified the key. Sperry's research supports the concept of contralateral processing, defined as processing which is carried out in the hemisphere opposite that receiving the sensory input.

Taylor's research on reading comprehension (1978) supports the notion that visual/spatial processing is the responsibility of the right hemisphere. In this research, it was demonstrated that iconic presentations (e.g.,

diagrams, charts, pictures) of verbal information (alphanumeric, auditory) facilitates comprehension, and the processing of this information is a function of the right hemisphere. Kimura (1973) also relates kinesthetics to the right hemisphere, due to the pronounced preference for use of the left hand in the reading of braille. In perceiving relationships, the right hemisphere is capable of simultaneously processing information (Rubenzer, 1979). If presented with several variables, the right hemisphere can process these variables best simultaneously rather than sequentially.

In verbal processing tasks, Kimura (1961) identified the left-right dichotomy and later (Kimura, 1967) conducted research in cerebral asymmetry in dichotic listening. This research indicated that melodic patterns are best processed through the left ear (right hemisphere), and words/digits are best processed through the right ear (left hemisphere). Additional research on aspects of right-hemisphere processing was conducted with left/right-hemisphere-damaged patients (Faglioni, Spinnler, & Vignolo, 1969). The results indicated that right-hemisphere-damaged subjects performed poorly on meaningless sound tests, and left-hemisphere-damaged subjects performed poorly on meaningful sound tests. The experimenters concluded that the recognition of non-verbal and perceptually complex auditory patterns are processed mainly in the right hemisphere.

Some research (Wittrock, 1978) indicates that the processing of music is different for trained musicians than for casual listeners. It is postulated that trained musicians process music through the left hemisphere. Trained musicians analyze the sounds and elements of music in much the same way as an individual deductively processes a word or sentence. With casual musical listeners, however, the emphasis in processing is on the global elements of music, and primary processing occurs in the right hemisphere. Zenhausern (1978) also supports the notion that input to the right hemisphere is processed holistically, but acknowledges that, at times, this hemisphere may be analytic in its processing. The importance of these "global" elements in processing is also supported by Kolers and Roediger (1984). In discussing information processing from the procedural perspective, the secondary features

(e.g., configuration of words, prosodic cues) are an important addition to primary features (e.g., symbology) for effective information processing. The results of these studies suggest that individuals possess initially preferred processing modes, but with increased skill or complexity, shared hemispheric processing responsibilities increase. As these skills encourage shared hemispheric processing, however, both holistic (secondary) and analytic aspects are important.

Although each hemisphere appears to have varying responsibilities, it is simplistic to assume a dichotomous relationship (e.g., Herrman, 1981; Luria, 1973; Schwartz et al., 1976). The interaction of both hemispheres is, instead, viewed as a complementary relationship. Hemispheric processing is a continuum in which dominance is distributed. The utilization of both hemispheres for certain tasks has been demonstrated, but differential aptitudes in functions may lead to the emphasis of one hemisphere over another in a particular individual's processing mode (e.g., Dumas & Morgan, 1975). It is postulated that approximately 68% of the general population is left-hemisphere dominant and 23% is right-hemisphere dominant, with approximately 9% of mixed dominance (e.g., Hart, 1983). Although emphasizing the cooperation of both hemispheres for effective information processing (e.g., Reynolds & Torrance, 1981; Rubenzer, 1979), the evidence of cerebral dominance is growing, and it appears that this dominance and lateralization of functioning develops quite early in life (Kinsbourne, 1975), during infancy and preschool years.

In research to support this notion, Bracht (1970) cites evidence that the emphasis on verbal input results in superior performance for subjects with low spatial ability and spatial input proves more successful for subjects with low verbal ability. Cohen and Freeman (1978) have found that left-handed individuals (thought to be right-hemisphere dominant) are poorer readers than right-handed individuals (thought to be mostly left-hemisphere dominant). In addition, left-handed subjects rely more heavily on the visual analysis of text and demonstrate more difficulty than do right-handed subjects when the text is visually distorted.

Read (1981), in research with subjects who have had a unilateral temporal lobectomy, studied the use of visual imagery in the processing of information. The results of the research suggested that imagery can be utilized by both hemispheres, but its use may be task-dependent. Read found that individuals with right-hemisphere damage could still use imagery when solving a deductive reasoning task (thought to be a left-hemisphere task). Individuals with left-hemisphere damage could not, and had difficulty solving the deductive reasoning task. He suggests the possibility of two types of imagery, alphanumeric/symbolic imagery and perceptual, which relates to the more global/spatial elements of imagery. If the left-hemisphere-damaged subjects were also left-hemisphere dominant, then this damage could, indeed, prevent the use of imagery since they may not systematically use much imagery in thought processing. Likewise, damage to the left hemisphere will create difficulty in solving deductive reasoning tasks, regardless of the use of imagery (alphanumeric or perceptual). The right-hemisphere-damaged subject, on the other hand, may utilize much imagery in solving all problems, and damage to the right hemisphere still enables the use of alphanumeric imagery. Pellegrino & Kail (1982) identified research procedures to begin to identify spatial aptitude with tasks.

Results of the neuropsychology research to date imply a lateralization of functions in the two hemispheres, with the right hemisphere predominantly responsible for spatial, holistic, inductive processing and the left hemisphere predominantly responsible for analytic, sequential, and verbal processing. However, cooperation between both hemispheres, for the most effective processing of information, is emphasized in research. There is evidence to suggest that although information is processed with both hemispheres, individuals tend to process information differently. These differences may indicate a dominance of one hemisphere over the other. Therefore, although processing capability is drawn from both hemispheres, individuals tend to emphasize the capability of one hemisphere as a "starting" place for information processing and this emphasis varies among people. This brief review of current research in neuropsychology indicates some agreement on the characteristics of left- and right-hemispheric processing. These

identified characteristics appear to relate to the dominant processing mode of individuals and are listed in Table 1. For example, if an individual is identified as "left-hemisphere dominant," the individual may display many of the identified characteristics of left-hemisphere dominance (see Table 1). Current research is only beginning to relate the characteristics within each processing mode to each other. Much of this study is conducted in the area of cognitive psychology. The review of cognitive psychology research attempts to combine neuropsychological research with additional research in cognitive styles.

Table 1. Characteristics of Left-and Right-Hemisphere Dominance

Left hemisphere	Right hemisphere
Analytic	Global/holistic
Deductive	Inductive
Verbal	Spatial
Difficulty synthesizing	Synthesis
Less prone to distraction	More prone to distraction
Introvert	Extrovert
Can resist influence of others	Can be influenced by others
Narrow attention deployment	More broad attention deployment
Uses phonetic cues in language interpretation	Uses non-phonetic cues in language interpretation
Maximizes differences between things	Minimizes differences in things (merge)
Language processing strengths	Kinesthetic processing strengths
	Sensitive to needs of others

III. CURRENT RESEARCH IN COGNITIVE PSYCHOLOGY

Results of neuropsychology research applied to the realm of cognitive psychology support the notion of cognitive style. Cognitive style, initially termed by Allport (1937), has been described as an individual's typical mode of thinking, problem-solving, perceiving, and remembering (Schwen, Bedner, & Hodson, 1979). Ausburn and Ausburn (1978) refer to cognitive style as the psychological dimensions that represent consistencies in an individual's method of acquiring and processing information. Cognitive style is thought to include all processes used in information processing: perception, thought, memory; imagining; and problem-solving. These individual differences in cognitive styles appear to be related to hemispheric dominance (Wittrock, 1978) and differences in modes of processing information (Ausburn & Ausburn, 1978). These differences are not related to which hemisphere is utilized, only to the degree to which one is used over the other.

Messick (1966) identified nine dimensions of cognitive style. Kogan (1971) and Lowenfeld and Brittain (1970) each added another dimension. Many reviews of the research conducted on these 11 styles (described in Table 2) have been written (e.g., Ausburn & Ausburn, 1978; Ragan et al., 1979; Wittrock, 1978). In addition to these dimensions, Kolb (1976) identifies two styles (or two aspects of cognitive style), each with two categories. The first style includes concrete experience and abstract conceptualization. This aspect of style depicts the continuum of thinking in terms of abstraction. The second category includes active experimentation and reflective observation. This style relates to the continuum of learner interaction with the environment. Therefore, Kolb continues to identify the continuum with a dichotomous relationship at each end.

Pask and Scott (1972) divide cognitive style into serialistic and holistic processors. Serialists view the world in a progressive, developmental, sequential pattern. Holists, on the other hand, relate to more global perspectives of situations. Serving as a basis for conversation theory (Pask, 1984), this serialist versus holist dichotomy has been used to define learner characteristics for the design of instruction.

Table 2. Fifteen Cognitive Styles

1. Field-independence versus Field-dependence (Witkin, 1965)
Individual differences as to the manner in which individuals perceive themselves in spatial terms. Field-independent individuals perceive analytically and can easily separate "figure" from "ground." Field-dependent individuals perceive globally and have difficulty organizing/separating simple from more complex figures.

2. Reflective versus Impulsive (Kagan, 1965)
Individual differences regarding the speed and manner in which hypotheses are selected and processed. Reflective individuals delay a long period of time before acknowledging a solution. Impulsive individuals select the first solution and are, as a result, many times incorrect.

3. Sharpening versus Leveling (Holzman, 1952; Klein & Schlesinger, 1951)
Consistent individual variations in memory assimilation (in the identification and integration of impressions). Sharpening reflects a tendency to maximize perceived differences and is less prone to confusion of similar stimuli. Leveling individuals minimize perceived differences and merge past memory.

4. Breadth of Categorizing (Kogan, 1971; Pettigrew, 1958)
Individual differences as to the degree to which an individual will include items within categories. Individuals with narrow categorization styles are resistant to the inclusion of many items in a single category. Individuals with a broad style demonstrate a willingness to include many items within one category.

5. Scanning (Messick, 1970)
Individual differences in attention deployment which produce variations in vividness of experience and range of awareness. Differences may be described in terms of narrow or broad deployment of attention.

Table 2. (Continued)

6. Tolerance for Unrealistic Experiences (Klein & Schlesinger, 1951)
Individual differences (demonstrated in research studies on apparent movement) as to willingness to accept perceptions which vary from experience. A less tolerant individual style is more bound to reality and has a more restricted range of illusionary movement. A more tolerant style allows for a broader range.

7. Cognitive Complexity-Simplicity (Kelly, 1955)
Individual differences in the tendency to interpret the world in a complex, multidimensional way. This includes the number of dimensions and individual forms in judgements or the number of discriminations within constructs. Current research reviews the continuum of abstractness/concreteness.

8. Conceptualizing Styles (Messick & Kogan, 1963)
Individual differences in the way individuals approach the categorization of similarities/differences among stimuli. This includes two aspects: equivalence range (very similar to breadth of categorization) and conceptual differentiation (differentiation-compartmentalization). Differentiation is the number of groups to which more than a single item is assigned. Differentiation correlates with verbal knowledge and vocabulary level (synthesis of information). Compartmentalization indicates the number of single items not placed in any categorical group. Compartmentalization correlates negatively with creativity and demonstrates difficulty in generating alternate conceptual schemes.

9. Constricted versus Flexible Control (Gardner, Holzman, Kelin, Linton & Spence, 1959)
Individual differences in individuals' vulnerability to cognitive and environmental distraction. A constricted style represents retention of incidental stimulation and a flexible style indicates failure of retention. Kogan (1971) questions this interpretation of terminology. For these purposes, the terms will be reversed.

Table 2. (Continued)

10. Distractibility (Santostefano, 1969)
The degree to which individuals react to contradictory cues. This is an "outgrowth" of constricted vs. flexible control which has been related to (but different from) field-dependence/field-independence. This style implies a range of individual proneness to distraction. This aspect of cognitive style has not been researched as thoroughly as others.

11. Visual versus Haptic (Lowenfeld & Brittain, 1970)
The degree to which individuals rely on visual or kinesthetic cues for information processing. The visual individual uses visual imagery, holistic processing, and the integration/synthesis of component parts. The haptic individual uses "bodily" perceptions, and is kinesthetically oriented. An "indefinite" individual combines the use of both.

12. Cautiousness versus Risk-Taking (Kogan, 1971)
Individual differences in willingness to take risks in decision-making situations. Although this dimension is usually task specific, there are some individuals who consistently perform at either cautious or risk-taking levels. Other individuals tend to react according to task.

13. Concrete versus Abstract Conceptualization (Kolb, 1976)
The degree of abstractness individuals utilize in conceptualizing information. A concrete conceptualizer uses concrete experiences; an abstract conceptualizer utilizes abstractions to conceptualize information.

14. Active Experimentation versus Reflective Observation (Kolb, 1976)
The degree of involvement preferred by individuals when learning a concept. Active experimentation refers to an active, "hands-on" style in learning as opposed to a more reflective, "thought-oriented" style.

Table 2. (Concluded)

15. Serialist versus Holist (Pask & Scott, 1972)
Individual differences as to the manner in which individuals prefer to input information. A serialist follows a deductive, analytical approach, with the preferred presentation sequence organized in a step-by-step, developmental format. A holist prefers to view the more global elements of information initially, then support these elements with sequential detailing.

Each of these cognitive styles indicates a bipolar relationship (Witkin, Moore, Goodenough, & Cox, 1977), with the two extremes of each defined. Current research in cognitive processing emphasizes the dichotomous, hierarchical functioning of the left and right hemispheres. In individuals, the range represents a continuum within the dichotomy, and an individual's style represents an emphasis toward one end or the other. It is proposed that this dichotomy of cognitive style may also relate to the dominance characteristics of left- and right-hemispheric processing. Many of the characteristics of left- and right-hemisphere processing appear to also relate to cognitive style dimensions. A proposed attempt to combine the research in neuropsychology and cognitive psychology is presented in Figure 1. As an individual progresses up the "thinking skills" hierarchy, thinking processes become more abstract, complex, and integrated (proposed by both left and right hemispheres). Characteristics of left- and right-hemispheric processing dominance are listed on the appropriate side of the triangular diagram in Figure 1, with the dichotomies of cognitive style matched to the characteristics of the two hemispheric processing patterns. The dimensions of conceptualization and learning behavior are proposed as both hierarchical and lateral characteristics. Other dimensions of styles are proposed as lateral characteristics with hierarchical blending toward complementary as "higher-order" thinking occurs.

One aspect of this dichotomy, verbal versus visual (spatial) processing, has been extensively considered. Lohman (1979) reviewed evidence of the division between verbal and visual/spatial processing. Verbal processing is defined as the recognition/retention of alphanumeric symbology, as in the reading of text. Visual (spatial) processing pertains to pictorial, graphic representations, including pictures. Kozlowski and Bryant (1977), in their study on spatial orientation and individual differences, acknowledge that individuals process spatial information differently and with varying degrees of success. Levin, Divine-Plavokins, Kerst, and Guttman (1974) also support learning style differences for words and pictures. The results of their study indicate that the use of imagery in reading with subjects who are "strong picture learners" enhances reading achievement. Imagery does not, however,

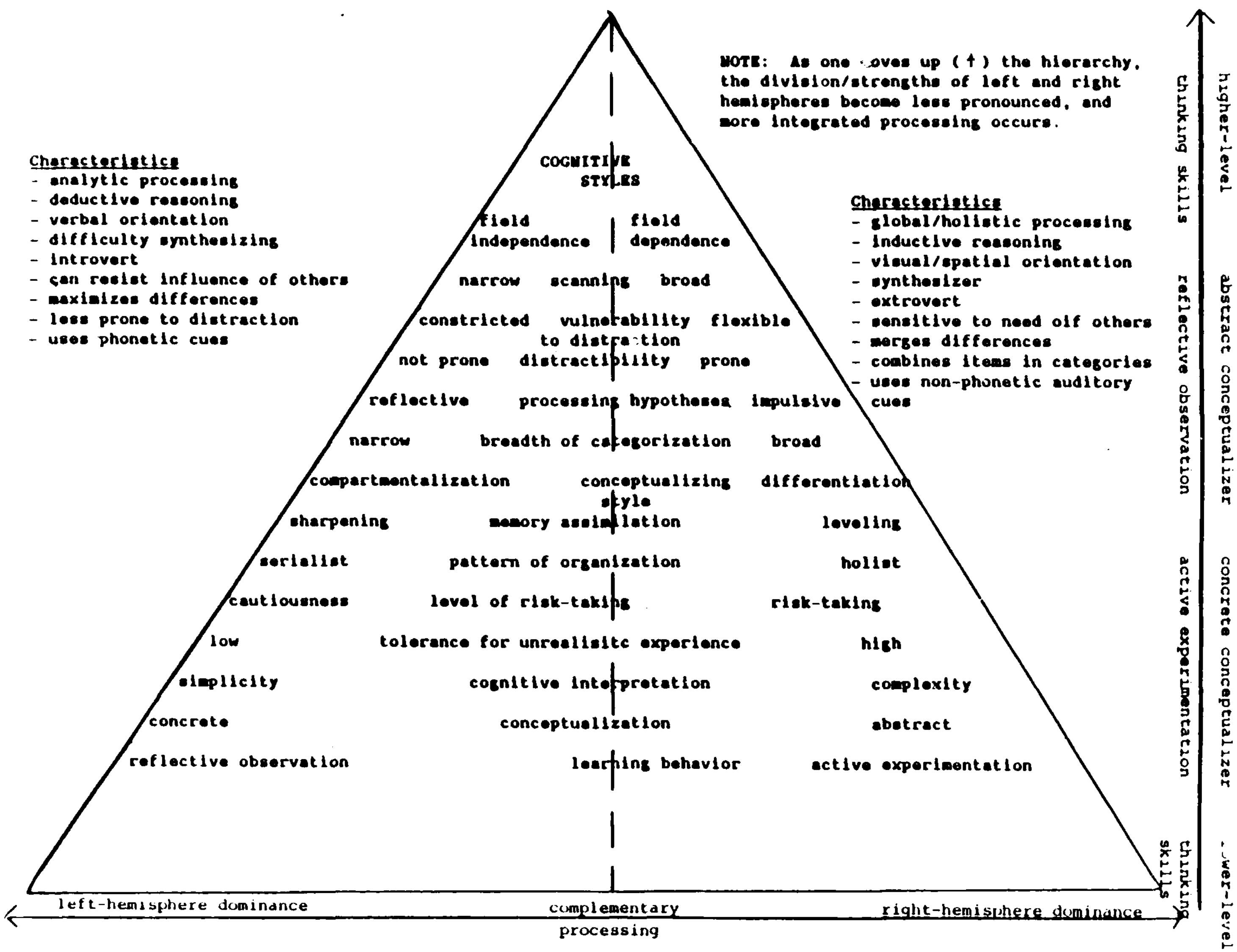

Figure 1. Style Characteristics and Thinking Skills.

help those subjects categorized as "weak picture learners." In a study on spatial information processing, Cooper (1982) reported that analytic processors show decreased reaction time for the recognition of more complex spatial information, whereas holistic processors do not. Holistic processors recognize global features of spatially presented materials, but when it becomes necessary to note fine details or features, analytic processors perform more adeptly. Holistic processors generally have difficulty noting details, whereas analytic processors demonstrate strengths in recognizing details but have difficulty with global information. Also Cooper presented spatial information to alternate visual fields (left-right) to determine hemispheric processing. Results indicated the same patterned response as in the previous study and led him to conclude that holistic/analytic cognitive processing style has no relationship to hemispheric processing, which would not support the serialist/holist division depicted in Figure 1. Cooper's conclusion did not, however, take into consideration the research on individual preference (strength) in cognitive style. If indeed individual learners have preference of style, then it would be difficult for them to modify this preference. Therefore, the patterned response would remain constant and Cooper may have attained these results for this reason; that is, individuals may respond most effectively in their dominant mode. Analytic processors (left-hemisphere dominant) would continue to "operate" in a dominant modality, and, if presented information contralateral to that mode, processing may still be affected.

In a study relating cognitive styles to reading comprehension, Pitts and Thompson (1984) found a relationship between inferential comprehension and the style dimension of field-independence/field-dependence. Cohen, Berent, and Silverman (1973) related field independence to lateral brain functioning. Inferential comprehension relates to an individual's ability to progress beyond factual knowledge to infer underlying concepts in the reading. It was found that field-independent students performed better in inferential comprehension than did those characterized as field-dependent. Wittrock (1978) related both the reflective and analytic style dimensions with left-hemisphere dominance, and impulsive, global styles with right-hemispheric

dominance. Ausburn and Ausburn (1978) also referenced evidence to demonstrate relationships between various style dimensions, as discussed. In addition, Zelnicker and Jeffrey's (1978) research findings supported a relationship between reflective and impulsive styles and left- and right-hemispheric processing strategies. They found impulsive style to be related to global (right) processing and reflective styles to analytic (left) processing.

Through research on cognitive style, some general characteristics of cognitive styles can emerge (e.g., Ausburn & Ausburn, 1978). First, it appears that an individual's cognitive style remains stable over time and across tasks (e.g., Garger & Guild, 1984). This style preference develops early in life and remains somewhat unchanged. The degree of dominance may change, but the direction appears to be stable over time. Secondly, although there seems to be only a minimal relationship between style and general overall ability (e.g., Satterly, 1976), the relationships between various style dimensions depicted in Figure 1 appear to hold true. That is, impulsivity, holistic processing, and inductive reasoning, for example, are identified as relating to each other and to right-hemispheric processing (e.g., Ausburn & Ausburn, 1978). Thirdly, there is evidence to suggest the relationship of cognitive style to particular learning tasks (e.g., Kozlowski & Bryant, 1977; Levin et al., 1974). When a task requires a transformation in processing that is incompatible with a learner's style, the learner may not perform the task successfully. It is, therefore, suggested that when it is known that classroom learning is affected by style, the instructional designer should consider cognitive styles as a factor when planning instruction. Since styles are resistant to long-term change and appear stable over time, it may be difficult to adjust an individual's style to meet a generalized instructional format. Many times, however, this is what instructional designers expect to occur. Often, training programs are designed without consideration of cognitive style and learners are expected to adjust to the style of the instruction. If a mismatch does occur, it could be interpreted that the learner is not successful in the assigned task. This can then be viewed as a learner-based problem. However, if this situation were instead addressed as an

instructional-based rather than learner-based problem, modifications could be made to the instruction to meet the individual needs of the learner. If the modifications are appropriate to the cognitive style of the learner, then perhaps greater success could be achieved and training enhanced. Viewing this situation as an instructional-based problem allows instructional designers the freedom and creativity to design interactive learner programs which individualize instruction.

IV. COGNITIVE STYLES AND INSTRUCTION

Accepting the postulate that relating cognitive styles to effective learning is an instructional rather than a learner-based problem, it becomes important to devise a manner in which instructional modification can be successfully accomplished. A look at current research in this area can begin to clarify the notion of the modifications to meet the individual needs of the learner.

Glaser (1976) proposed a "psychology of instruction," wherein the goal is to provide the linkage between the psychological knowledge of learning and the educational applications of this knowledge. Considerations in developing this linkage include both research on cognitive styles and analysis of the tasks to be learned. According to Miller (1980), the instructional designer's role is to devise conditions in the learner's external environment which support the learner's internal cognitive processes.

Federico and Landis (1984) supported the importance of designing instruction in consideration of cognitive style dimensions in order to aid individuals in learning information more readily and retaining/retrieving information more effectively. Others (e.g., Birkey & Moon, 1984; Grasha, 1984) have also stressed the importance of matching instructional mode and cognitive style. Grasha (1984) cautioned, however, that too consistent a match could create a non-motivational attitude in learners, by not encouraging accommodation to variety. As has been emphasized previously, however, the most effective learning occurs with cooperative processing of both hemispheres. This would then imply the use of a variety of instructional methods to promote optimum

utilization of integrative ("whole brain") processing.

A question arises as to the most appropriate matching of individual cognitive style and the requirements (subject matter) of the task for the most effective model of instructional presentation. Classification systems attempting to address these issues have been somewhat vague in demonstrating the interactions of style and subject matter (Ausburn & Ausburn, 1978). An initial attempt at developing such a classification (Ausburn, Ausburn, & Ragan, 1980) is laudible, and could be expanded and specified. Such a listing would identify tasks and the cognitive style related to each task. If, however, many cognitive styles are related, it would be reasonable to assume that most styles may be involved (to varying degrees) in every task. Therefore, improved performance might be achieved based on the mode of the presentation of information which takes into consideration both style and task.

Wittrock (1979) supports the utility of addressing process-oriented individual differences in the design of instruction. He discusses several dimensions of cognitive style (analytic-global, field-independent/dependent, and serialistic-holistic) and the implications of these styles in aptitude-treatment interactions. Wittrock considers the aptitudes (styles) of an individual and the ways in which these aptitudes interact with, or are affected by, the treatments (in this case, instructional programs). In her principles of instructional design, Baggett (1983) also emphasizes the design of individualized instruction based upon knowledge about cognitive styles.

Through the research on cognitive style and the initial support of the interaction of style and instruction, several general principles seem to emerge which may be applied to the presentation of computer-based instruction:

1. Individuals vary in the way in which they most effectively process/retain information.

2. The cognitive styles of individuals differ in relation to their hemispheric dominance in information processing.

3. The best learning occurs when a learner processes information utilizing both hemispheres.

4. The design of instruction should consider cognitive styles of individual learners, emphasizing the notion of "whole-brain" processing.

5. Based on research in cognitive styles, instruction should consistently include:

a. Opportunities for an individual to adjust aspects of the instructional environment (e.g., order of presentation, perspective taken, questions asked/answered).

b. A combination of verbal information (text, auditory input) and spatial information (graphics, pictures, graphs, etc.) which are closely related to one another.

c. The advanced organization of the training program through an initial overview of the training, opportunities for review, and reinforcement.

d. Opportunities for the learner to apply the new information to a variety of learning situations in order to enhance retention and transfer.

6. It is suggested that both the instruction and the testing should be consistent with the learner's cognitive style. For example, if the training program itself provides both visual and verbal information, then the testing should provide for both visual and verbal information as well. Little research has been done in this area. In a study conducted by Moore and Nawrocki (1978) on the effectiveness of graphics for computer-based instruction, the mode of testing was not consistent with the mode of instruction. In this study, a written textual test was given after all treatments, including the graphics treatment condition, and the use of graphics was not supported. Moore, Nawrocki, and Simutis (1979) identified the difference between the instructional mode and the test mode as a problem with this study. Therefore, if an individual has learned the information

graphically, it may be most useful to test retention in the same format (graphically) unless transfer to verbal format was consistently reinforced.

Although these proposed general principles have not been consistently developed and researched, some research has been conducted on various dimensions of cognitive style and their interactions with instruction. Bush, Gregg, Smith, and McBride (1965) conducted a study which included five presentation conditions including text (two conditions), graphics, listening, and the use of audio-visual materials (film, etc.). The results of the study indicated that individuals with high reading comprehension performed better under the verbal (text) conditions. Likewise, the performance of lower-skilled readers was enhanced by the use of graphics, films, and other spatially oriented materials. Although these results may not be surprising, they support the need for systematic integration of graphics in instruction. These results relate to Cohen and Freeman's (1978) study of readers discussed earlier, which indicated that left-hemisphere-dominant individuals, in general, are better readers and that the use of visual/spatial information can enhance comprehension for poorer readers (thought to be right-hemisphere dominant).

In research on imagery, Ausburn (1976) studied visual and haptic cognitive styles and each group's use of imagery. Visual learners performed better than haptic learners on visual imagery tasks. Both groups performed better under multiple (simultaneous) imagery conditions than with linear (sequential) presentation. This supports the relevance of cognitive style to learning specific tasks and gives some initial evidence as to the importance mode of presentation may have on learning specific subject matter. Other studies (Hauck & Verstegen, 1983; Rigney & Lutz, 1974) also support the use of imagery in instruction to enhance learning.

Another aspect of cognitive styles and the display of information was shown in a study with military personnel conducted by Geiselman and Samet (1982). They discovered that learning performance was enhanced when subjects were permitted to organize/format information to meet their individual

styles. Subjects preferred to spatially arrange information according to their own preferences, and their performance increased with their ability to do so.

Some instructional techniques are particularly useful for adapting to various cognitive style dimensions. Table 3 shows a proposed listing of possible instructional strategies that may be matched to particular cognitive styles in order to enhance instructional effectiveness. Much of the current computer-based instruction is dichotomous (visual-verbal) in the nature of its presentation. Research on the interaction between cognitive styles and instructional design suggests some possible presentation formats for presenting visual-verbal information effectively:

1. Verbal-visual information should be presented in such a manner as to increase processing and decrease the opportunity for resource competition (Wickens, Sandry, & Vidulich, 1983).

2. The use of visual in addition to verbal information seems to result in less time to complete tasks and in higher retention, both short-term (King, 1975) and long-term (Baggett & Ehrenfeucht, 1983).

3. When verbal (text or auditory input) and visual (spatial) information are both presented, the most effective mode of presentation appears to be to present them in synchrony, or to present the visual before the verbal (Baggett & Ehrenfeucht, 1983).

4. When both verbal and spatial information are presented in synchrony, it may be advantageous (due to contralateral hemispheric processing of the visual field) to place visual information to the left of the verbal information (Wickens, 1984a). With visual information to the left of the visual field, it may be more effectively processed by the right hemisphere.

5. More imaginative, rather than traditional, use of media to supplement text can be effective (Jamison, Suppes, & Wells, 1974). Creative use of graphics, films, etc. appears to enhance training performance.

Table 3. Cognitive Styles and Possible Instructional Modifications

1. **Field-Independence**	**Field-Dependence**
- use advanced organizer to define advanced relationships - use highlighting - review to synthesize information	- use advanced organizer - use highlighting - review to direct synthesis of information
2. **Reflective**	**Impulsive**
- adjust the pacing of instruction - highlight points of emphasis during instruction	- adjust the pacing of instruction to "slow down" for effective performance - highlight points of emphasis during instruction
3. **Sharpening**	**Leveling**
- demonstrate relationships through use of a "web" - use mnemonics to combine characteristics - utilize all levels of questioning to force combination of training components	- highlight differences - use mnemonics to direct combinations - use variety of questioning techniques to focus and direct attention
4. **Narrow Categorization**	**Broad Categorization**
- use "webs" to structure information - use advanced organizers to provide overview of training - use frequent review and reinforcement to combine training components	- use webbing to structure information - use advanced organizers to focus attention on important aspects of training program - use highlighting to direct attention

Table 3. (Continued)

5. Narrow Scanning	Broad Scanning
- spread spacing on page and use highlighting	- focus attention with use highlighting
- use graphic symbols as keys to direct attention	- use graphic symbols as keys to focus attention
- display information at different times to clearly direct attention	- display information at different times to clearly direct attention
6. Low Tolerance for Unrealistic Experiences	High Tolerance for Unrealistic Experiences
- uso realistic examples (visual and verbal)	- use realistic examples (visual and verbal
- use a variety of examples for application of concepts	- use a variety of examples for application of concepts
- use actual materials whenever possible	- utilize color and graphics to enhance interest
7. Cognitive Simplicity	Cognitive Complexity
- use highlighting to narrow field of vision	- provide graphic organizer (cognitive map) to organize
- use outline/mapping to organize information	- utilize realistic examples to apply training to variety of situations
- arrange information well-spaced on screen (minimize "clutter")	- use mnemonics to combine and classify information

Table 3. (Continued)

8. Compartmentalization - use webbing/mapping - choose experiences forcing the combination of categorization - use variety of questioning techniques and feedback to encourage the identification of interrelationships among training components	Differentiation - use webbing/mapping - use highlighting to classify appropriate information - provide realistic examples demonstrating application of training information
9. Constricted - use highlighting to emphasize - use different sizes of lettering, etc., to stress organization of information - add additional information progressively	Flexible - use highlighting to narrow focus of attention to important training components - utilize graphics and color to provide interest and examples of information presented - provide frequent opportunities to review/reinforce information presented
10. Not Prone to Distraction - arrange information on screen for best retention of greatest possible amount of information - allow trainee flexibility to determine amount of feedback and review - use graphics and color to vary presentation mode	Prone to Distraction - limit amount of information displayed at a given time - use highlighting to direct attention - provide frequent feedback and reinforcement - provide frequent review using color and graphics

Table 3. (Continued)

11.	Visual - use color and graphics to reinforce ideas - provide realistic experiences to provide opportunities to apply training - provide outline for organization of training	Haptic - use color and graphics to reinforce concepts - provide experiences in working with equipment, etc. (i.e., "hands-on" training) - provide realistic examples to assist trainee in applying information presented
12.	Cautiousness - use directed learning experiences - provide experiences for aided generalizations - provide experiences which become sequentially more complex	Risk-Taking - use directed learning experiences to control amount of information and direct attention - use highlighting to focus attention on appropriate information - provide experiences which become sequentially more complex
13.	Concrete Conceptualization - begin with concrete experience and move toward abstract - use mnemonics to combine and categorize training content - use webbing to show relationships among training components	Abstract Conceptualization - begin with concrete experiences, allowing flexibility for holistic processing - provide realistic experiences to apply knowledge gained - provide opportunities for frequent review and reinforcement

Table 3. (Concluded)

14.	Active Experimentation - provide opportunities to apply information to realistic situations - give realistic examples throughout training program - provide frequent review and reinforcement to apply knowledge	Reflective Observation - allow flexibility in pacing presentation - allow flexibility for reviewing information presented - provide realistic examples of applications of information presented
15.	Serialist - provide learning experiences in sequential manner - gradually induce holistic processing - use questioning to force both sequential and holistic processing	Holist - introduce information holistically - force sequential development of concepts within a holistic framework - use questioning to force both sequential and holistic processing

6. When visual information is presented, it appears that it is most effective to locate the critical visual information in the center of the visual field (Neumann, 1984). Neumann notes that this position may vary in size depending upon the perceptual grouping pattern of an individual. It may be possible that this also relates to cognitive style.

7. Proper spacing of information appears to be important for adequate information processing. For example, Hathaway (1984) found that textual material is read more easily when double-spaced than when single-/triple-spaced.

(NOTE: Additional specific guidelines for developing visual displays can be found in Smith [1979] and Dansereau et al., [1975].)

Increased use of auditory input in computer-based instruction could expand the presentation model for individualized instruction in the near future, but verbal/visual modes are more predominant at this time.

V. RESEARCH CONCERNS

Research of cognitive styles relative to instructional design is still in its infancy. Future research could focus on the following concerns:

1. Is there a correlation among the dimensions of cognitive style as depicted in Figure 1?

2. Do these cognitive styles affect all learning situations? To what degree?

3. Can other instructional strategies (such as those listed in Table 3) be utilized to enhance complementary processing of information with both hemispheres? Are there certain strategies appropriate for a given cognitive style dimension?

It is possible to look at the progression of instruction in a hierarchical

format similar to that in Figure 1. Various dimensions of cognitive style can be related to steps in the instructional design of a lesson. Likewise, instructional strategies can be related to both the lesson and the style dimensions. Figure 2 displays a proposed hierarchical flow of instruction, strategies, and cognitive style. Additional research concerns relating to Figure 2 are:

4. Does the interaction of lesson design, cognitive style, and instructional strategies progress according to the hierarchy postulated by the author in Figure 2?

5. Can a taxonomy or listing of instructional guidelines be developed to enhance the effectiveness of training programs and achieve increased success in learning?

As research continues to identify the relationships between the various dimensions of cognitive style, more specific trainee characteristics can be identified, and guidelines for the most effective presentation of information in training programs can be developed.

VI. THE DEVELOPMENT OF INSTRUCTIONAL GUIDELINES

If there are proposed correlations among style dimensions and it is possible for instructional strategies to be matched to style and subject matter (task requirements), it would be helpful to instructional designers to have guidelines for the development of instructional programs. Learner cognitive style and mode of presentation are only two areas to consider. What many researchers considering aptitude-treatment interactions are missing is the manner in which these two areas interact with content (subject matter). Staver's (1984) study suggests that format should be based on the type of information presented. As Ausburn (1976) concluded, subject-matter content indicates a preferred mode of presentation. Trafton (1984) recognized that mathematics instruction was more effective when knowledge about the instructional mode best utilized for content was emphasized. Wickens (1984b) discussed the possibility that certain operations

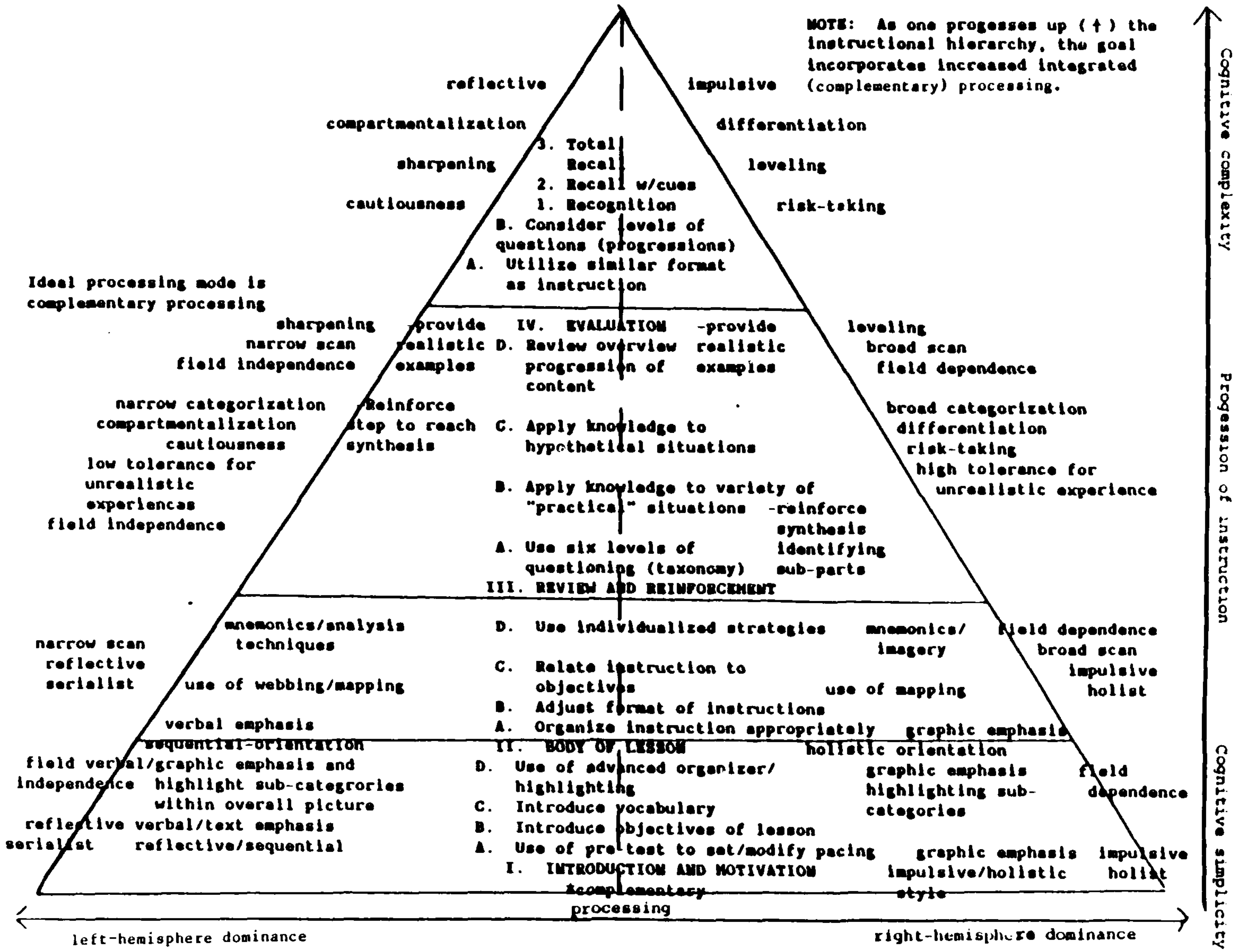

Figure 2. Style-Instruction Interaction.

(e.g., computational and problem-solving) can be trained utilizing either spatial or verbal code, and noted that this decision may be task-dependent.

Taxonomies developed to explain the learning process have gained wide acceptance (e.g., Bloom, 1956; Gagne, 1965). Some taxonomies have dealt with higher-order thinking skills (e.g., Stuart & Burns, 1984). Some taxonomies for use by instructional designers have combined task and content (Merrill & Boutwell, 1973). Moore & Nawrocki (1978) adapted the Merrill and Boutwell (1973) taxonomy for research which focused on graphics in computer-assisted instruction.

A taxonomy that could be useful to instruction designers would combine dimensions of cognitive style, content, and mode of presentation. Development of such a taxonomy or set of guidelines is supported by researchers in this area (Glaser, 1976; Grasha, 1984; Moore & Nawrocki, 1978).

The author's review of the literature on taxonomy development for human performance (e.g., Fleishman, 1967, 1975; Miller, 1971; Wheaton, 1968) led to a proposed instructional guideline instrument in Table 4, which is designed for computer-based instruction and which could serve as a basis for further research in this area. The table lists cognitive style dimensions and provides an initial classification system for subject matter. These classification areas are defined as follows:

Knowledge. Content includes factual information necessary for an individual's general and specific knowledge about a particular topic. This information may be necessary for performance of a specific task and can include areas such as mathematics, history, procedures, descriptions, etc.

Skills. Content contains information enabling the carrying out of an action. This includes the "hands-on" type of information necessary for performing an act and may rely on subject matter in the knowledge area. Skills include such tasks as operating a radar system, repairing a portion of a plane, flying a plane, ordering munitions, etc.

Table 4. Training Strategies for Identified Cognitive Styles and Subject Content

DECISION MAKING	ATTITUDES	SKILLS	KNOWLEDGE	COGNITIVE STYLES
-goal statements -simultaneous overall picture w/highlighting -realistic experience	-provide both cognitive and emotional reasoning/ support -provide experiences which allow for several viewpoints	-provide paper-based/material-based information to demonstrate part/ whole -color-coding -numbering steps/items	-agenda/advanced organizer -building block approach w/ frequent review -text and graphics w/highlighting -adjust text size	field-independence field-dependence
-pre-test to determine mismatches -examples to show results of actions -controlled pacing	-allow "thought time" -interactive format -encourage alternate viewpoints as options	-exploration time in addition to sequential development -pre-test	-use branching to direct learning -adjust pacing through pre-test	reflective impulsive
-mnemonics -use of questioning to direct attention to important components	-allow time for sharing thoughts -provide experiences in which many opinions are expressed	-icons/mnemonics as memory aids -diagrams in addition to actual materials	-webbing to show relationships -highlight to show component parts -advance organizer	sharpening leveling
-highlighting -provide applied structured situations to direct categorization appropriately	-demonstrate results of opinions (small-/large-scale) -discuss similarities/differences among varying opinions	-flow charts -discussion of similarities/ differences through observation -color-coding	-advanced organizer -highlighting -webbing -mnemonics	narrow categorization broad categorization
-use of both text /graphics simultaneously -use of highlighting to stress application of information	-highlighting to focus/re-focus attention -provide experience to review opinions and structure thoughts	-concentrate on one aspect at a time/provide materials in addition to equipment -structure w/ frequent review /reinforcement	-use of text and graphics display simultaneously or graphics first -provide overview and frequent review of information	narrow scan broad scan

Table 4. (Continued)

DECISION MAKING	ATTITUDES	SKILLS	KNOWLEDGE	COGNITIVE STYLES
-realistic display -demonstrate results of choices made by trainee	-provide realistic examples and experiences -provide examples from several viewpoints	-use actual materials during training or closely simulated materials -use of text and graphics w/ materials	-relate knowledge to practical examples, then move to more abstract -use of both text and high-resolution graphics	low tolerance for unrealistic experiences high
-freedom to arrange display format individually -demonstrate results of choices made	-provide examples demonstrating varying viewpoints -use "webbing" technique to demonstrate interrelationships	-provide examples for application purposes -provide frequent review/reinforcement	-apply knowledge to variety of situations -relate to knowledge base of individual experience	compartmentalization conceptualizing differentiation
-provide structured experiences, provideing larger amount of decision making as trainee progresses	-provide variety of examples and discuss pro/cons -use of multi-level questioning techniques	-mnemonics/icons as memory aids -allow flexibility in pacing/review	-use of mnemonics -use of icons for memory techniques and categorization	constructed control flexible control
-small steps and demonstrate results of choices -structure initial choices w/ narrow options moving to wider range	-use of visual aids to demonstrate results of various choices -decision-making activities to demonstrate	-exploration time -flexibility to adjust work environment -demonstrate results of actions	-progress developmentally to higher-level thinking -provide practical examples/applications of knowledge	cautiousness risk-taking
-text and graphics simultaneously -highlighting to emphasize salient features necessary for decision making	-use of visual aids to direct thoughts -use of highlighting to emphasize likeness and differences	-provide actual/realistic experiences -direct attention through mnemonics/icons as memory aids	-use highlighting to focus attention appropriately -use of graphics closely related to text and presented simultaneously	not prone distractibility prone

Table 4. (Concluded)

DECISION MAKING	ATTITUDES	SKILLS	KNOWLEDGE	COGNITIVE STYLES
-permit individual formatting of information -allow freedom to explore/demonstrate results	-provide opportunities for both sequential and holistic thought -use multi-level questioning for flexibility	-show both overall picture and parts -allow freedom to explore materials while also providing some directed structure	-adjust sequence of presentation -provide frequent examples of larger picture-webbing -combine text and graphics	serialist holist
-provide realistic experiences through text and graphics moving to simulations, etc. -provide examples to demonstrate results of choices	-provide realistic experiences to demonstrate varying viewpoints -provide simulations, "hands-on" experiences	-provide trainee w/text/graphics simultaneously -provide actual materials, film, etc. of materials	-use of text and graphics -provide application experiences for trainees	visual haptic
-movement from concrete examples relevant to trainee to variety of situations -demonstrate results of choices made by trainee	-movement from trainees' point of reference to vary viewpoints -provide realistic applications	-movement from concrete to abstract w/application to variety of situations -begin from trainee's concrete experience level	-use pre-test to determine knowledge base of trainee -begin w/concrete experiences/text /graphics	concrete conceptualization abstract
-movement from experience directly relevant to trainee's experiences to more varied situations -flexibility of "think time" w/ sequential development to shorten time required	-provide simulations, role-playing, etc. -allow "thought-time" for processing of information	-allow directed exploration -provide feedback and adjust structure to individual progress	-begin w/freedom to explore by acknowledging knowledge base -questioning techniques which direct ideas and provide think time	active experimentation reflective observation

Attitudes. Content involves information relating to the acceptance/understanding of subject matter. This may include attitudes toward mathematics, handling weapons, interpersonal communication, etc.

Decision Making. Content involves a combination of two or more areas. Tasks include mission planning, mission implementation, etc.

It is important to note that these are not discrete categories. Future work should delineate and define the content in a more detailed, specified manner. Located at the junction points of cognitive style and subject-matter content are an initial listing of instructional strategies to encourage integrative processing while also meeting individual needs of learners.

VII. RELEVANCE TO AIR FORCE TRAINING AND FOLLOW-ON RESEARCH

Up to this point, discussion has focussed on current research issues relevant to general instructional design concerns. In the area of military training, this information can be especially useful.

Current military training follows many design procedures, one of which is the Instructional Systems Design (ISD; Department of the Air Force, 1979). ISD approaches instruction in a behavioral (sequential, programmed) manner and identifies steps for the development and evaluation of training programs. This model includes the following steps:

1. Analysis of system requirements
2. Definition of education/training requirements
3. Development of objectives and testing
4. Planning/validating of instruction
5. Instructional implementation and evaluation.

The considerations of cognitive style dimensions and subject-matter content can be applied at each step in the ISD process. Initial guidelines such as those proposed in Table 4 can be useful at each step in the planning, implementation, and evaluation of instruction. Style and content considerations can influence the initial system analysis (Step 1 in the ISD process) as well as the planning, implementation, and evaluation of instruction. Miller (1980) recognized that ISD, with its behavioral emphasis, does not reflect current research in cognitive psychology. Consideration of style dimensions can, however, be easily integrated into this process. In Table 4, considerable overlap in instructional strategies is evident, but an awareness of the purpose of each of these strategies in the context of content and style for each category may be crucial to effective training programs.

A significant trend in the military is the increased use of computer-based individual training. In many such programs the learner must adapt to the format of the instruction. The exciting potential of computer-based instruction is the capability to create individualized instruction, designed to be modifiable to meet the needs of all learners in a variety of learner settings and situations. The increased use of computer-based instruction in military training allows for the use of the knowledge of cognitive styles to enhance training. If improved learning occurs through cooperative hemispheric processing, individualized computer-based instruction can enhance this cooperation through the use of a variety of combinations of text, graphics, and eventually sound. Recent reviews of computer-based instruction (e.g., Montague & Wulfeck, 1984) support the development of individualized instruction through the application of theories of information processing and learning styles.

Most training programs emphasize training efficiently, effectively, and in a cost-effective manner. Training programs designed with an awareness of cognitive style characteristics should take less time and result in enhanced comprehension. Likewise, if methods are employed throughout training to enhance higher-order thought and cooperative hemispheric functioning, this may also result in long-term retention and transfer of information. Over time, this can affect length of training, effectiveness of training, and cost.

Artificial intelligence research can also serve as a tool in enhancing military training. Artificial intelligence techniques can be used in computer-based instruction to pre-assess trainee cognitive styles and design instruction to address both the strengths and weaknesses of trainees. Some dimensions of cognitive style have been addressed in the development of authoring systems utilizing artificial intelligence (e.g., Gable & Page, 1980; Pangaro, 1982).

This paper raises several important issues relevant for follow-on research and indicates the possibility of improved training through the development of guidelines for instructional designers which consider the interaction of both cognitive style and subject matter. A major research issue that may lead to the development of such guidelines may be formulated as follows:

> The retention of instructional information modified in presentation format matched to cognitive style and subject-matter content.

This issue could be addressed through basic research designed to test the strategies outlined in Table 4.

It can be possible through further research to design military training to meet the individual cognitive style of the learner. The goal is not to develop instructional programs geared solely to the dominant style of the trainee, but to enhance the individual's potential for higher-level cooperative processing which can, in turn, result in more effective learning through the use of increasingly effective training technology.

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